APPENDIX C

DEPARTMENT OF TRANSPORTATION WEATHER PROGRAMS

FEDERAL AVIATION ADMINISTRATION

The FAA has the responsibility to provide national and international leadership in the optimization of aviation weather systems and services. This leadership is manifested through the management of a safe and efficient National Airspace System (NAS) and the encouragement of consensus and cooperation between government agencies, private weather services, research organizations, and user groups involved in aviation weather.

AVIATION WEATHER MANAGEMENT

NAS Management. For the last few years, the Federal Aviation Administration (FAA) has been focusing on initiatives to prevent accidents and delays attributable to weather. The focus on these initiatives underscored the need for centralized aviation weather program management. Feedback from users and other weather service providers only reinforced the FAA commitment to meet that need.

By necessity, operational aviation weather activities needed to be dispersed among FAA organizations responsible for the day-to-day operational responsibilities. The research and acquisition activities associated with the aviation weather program have already been centralized into the Office of Research and Acquisition. However, the policy and requirements functions for aviation weather were dispersed throughout the offices of Flight Standards Services, Airway Facilities Requirements and Life-Cycle Management, Air Traffic Plans and Requirements, and System Capacity and Requirements. The dispersal of these activities over four different organizations was an obstacle to the development and management of an aviation weather program that would meet the needs of the NAS envisioned for the 21st Century.

In 1995, the Associate Administrators for Air Traffic Services, Regulation and Certification, and Research and Acquisition agreed to centralize FAA aviation weather policy and requirements functions into one multidiscipline organization. The Associate Administrator for Air Traffic Services supported the location of the new organization within the office of Air Traffic Requirements Service. On October 1, 1995, the Aviation Weather Division was established and staffed with personnel from diverse backgrounds, such as flight standards, meteorology, airway facilities, and air traffic. A reorganization that established the Air Traffic Requirements Service in early 1997 elevated Aviation Weather to a Directorate.

Most of the ongoing activities within FAA aviation weather program are well known. First, FAA works in partnership with many other government agencies to integrate aviation weather issues and activities into the overall national weather program. The partnership with the National Weather Service (NWS), that has been in existence for decades, is enjoying a revitalization with the establishment of the new weather division. The new division is working diligently to reaffirm FAA's leadership role in aviation weather and the important role of NWS in meeting aviation weather requirements.

During the next 5 years, FAA will focus on four major areas for aviation weather services:

- Roles/responsibilities.
- Training.
- Technology.
- Investment strategies.

This focus will provide some immediate benefits and, more importantly, will strengthen the foundation for future NAS services.

Roles and Responsibilities. The successful execution of a national aviation weather program is first dependent upon an explicit and mutually understood definition and acceptance of roles and responsibilities both within and outside of the FAA. The execution of these roles and responsibilities have been enhanced by the chartering and complete staffing of the Aviation Weather Division, clarifying FAA lines of business, and completing intra-agency and interagency plans.

Training. Aviation weather information, which is complex and highly perishable, is most useful when customers can successfully plan, act, and respond in ways that avoid accidents and delays. FAA will improve the ability of the aviation community to use weather information through a review and upgrade of airmen training and certification programs. FAA will also develop multimedia training tools to support aviation safety and training initiatives.

STRATEGIC VIEW FOR AVIATION WEATHER MODERNIZATION

Although many of the weather activities described in this Appendix were initiated before the creation of the Aviation Weather Division, the new division will lead the development of a strategic view for a national aviation weather program and further develop the plan for implementing that program. There are four major drivers of this strategic view.

First, there is operational urgency. The FAA is committed to the prevention of accidents and delays attributable to weather. From 1989 through 1993, 23 percent of all aviation accidents were attributable to weather. In 1992, 65 percent of all delays were attributable to weather at an estimated cost of over $4 billion. The projected growth of domestic traffic over the next 10 years demands the implementation of programs that increase capacity while continually maintaining mandated safety standards. A "weather-wise" program for the 21st century will anticipate and meet user requirements for both safety and capacity.

The next driver is the large and diverse group of stakeholders in the national aviation weather program. The large number of stakeholders increases the competition for limited resources; the diversity of stakeholders frequently results in conflicting objectives and priorities. The ability to integrate the needs and requirements of these stakeholders into the policies, investment strategies, and performance metrics of the national program will be key to its success.

The rapid advancement of aviation technologies is the third driver of this strategic view. The plan will redefine and clarify basic assumptions about the nature and delivery of aviation weather services. There will be a renewed emphasis on weather information as opposed to weather data. Aeronautical Data Link will enable simultaneous real-time dissemination of weather information to both the pilot and the air traffic controller. FAA will develop display and decision-making tools that enhance rather than burden decision making. FAA will develop procedures to support the users of this new technology as well as those users who will continue to rely on ground-based information systems. Human factors studies demonstrate the need to find the optimum balance point between technology and human performance. This need will be a key consideration in the design and placement of new equipment; in the training of pilots, dispatchers, and controllers; and in the regulations and procedures applicable in the NAS.

The final driver is consideration of the changing role of government and the diminishing funding of government services. Clearly the federal government is obligated to lead the development of a national aviation weather program, and this program should, by definition, consist of standards for and definitions of program requirements and services. However, to what extent should and can the federal government accept the responsibility for funding aviation weather services? Unfortunately, a world of unlimited resources does not exist. The more fundamental question, regardless of resources, is the appropriate role of the federal government. At this point, these questions cannot be answered; but, with a "weather-wise" strategic view, the FAA, along with other stakeholders, may be able to influence the answer.

<u>Technology</u>. Aviation weather technology includes the ways in which aviation weather information is gathered, disseminated, and displayed. The development of this technology also demands that consideration be given to human factors and the application of decision-making tools. FAA will support the use of technology by improving aviation weather information through integration of federal and non-federal resources; applying human factor considerations to the content, format, and dissemination of weather information; and establishing configuration management criteria for the software and hardware elements of aviation weather systems.

<u>Investment Strategies</u>. Sound investment strategies are characterized by the integration of many activities, primarily those of identifying, planning, and evaluating. Over the next 5 years, FAA will develop a sound investment strategy for a national aviation weather program that:

- Communicates the aviation weather objectives.
- Describes where the FAA wants to be.
- Considers all FAA and non-FAA funding for aviation weather that contributes to NAS performance.
- Develops and uses metrics that provide information on the performance of the national aviation weather program.

AVIATION WEATHER ACQUISITION AND SERVICES

One of the primary functions of the new organization is the development and management of requirements for the FAA Capital Investment Plan. Recent projects have focused on weather detection and display systems for pilots and air traffic controllers to ensure that aircraft avoid hazardous weather. The following paragraphs describe those projects.

Terminal Aviation Weather Programs

The Integrated Terminal Weather System (ITWS) will integrate weather data from sensors in the terminal area to provide and display compatible, consistent, real-time products that require no additional interpretation by controllers or pilots--the primary users. ITWS will use data from automated surface observing systems, Doppler weather radars, and low-level windshear alert systems, together with NWS data and products, to forecast aviation impact parameters, such as convection, visibility, icing, and windshear, including downbursts. Initial capabilities will include sensors available now through the late 1990's. The development is now in the demonstration phase at several airports in various climatic regimes. ITWS will operate at about 45 high activity airports that are supported by terminal Doppler weather radars. Full implementation is expected after the turn of the century.

The Terminal Doppler Weather Radar (TDWR) program consists of the procurement and installation of a new terminal weather radar based on Doppler techniques. TDWR units will be located to optimize the detection of microbursts and windshear at selected high activity airports. In addition, it will have the capability to identify areas of precipitation and the locations of thunderstorms.

Microbursts are weather phenomenon that consist of an intense downdraft with strong surface outflows. They are particularly dangerous to aircraft that are landing or departing. TDWR scanning strategy will be optimized for microburst/windshear detection. The radar will be located near the airport operating areas in a way to best scan the runways, and the approach and departure corridors. The displays will be located in the tower cab and Terminal Radar Approach Control (TRACON).

FAA has ordered 45 TDWR systems and 2 support units for training and testing. Deliveries will be completed by the end of calendar year (CY) 1997. A software upgrade has been initiated to integrate TDWR and low level windshear alert system data.

The Low Level Windshear Alert System (LLWAS) provides pilots with information on hazardous windshear conditions that create unsafe conditions for aircraft landings and departures. A total of 110 airports have LLWAS. The basic system consists of a wind sensor located at center field and five sensors near the periphery of the airport. A computer processes the sensor information and displays windshear conditions to air traffic controllers for relay to pilots.

The LLWAS-Network Expansion (LLWAS-NE) is the first step in the FAA's efforts to upgrade the NAS capability to detect windshear. The earlier, six-sensor systems provided adequate protection against microbursts; however, testing at Denver Stapleton Airport and Orlando International Airport have resulted in the development of two more sophisticated windshear detection systems--LLWAS-NE and LLWAS-3. LLWAS-NE will include expanding the network of sensors, improving sensor siting and providing runway-oriented alerts.

The improvement phase, referred to as LLWAS-3, will include expanding the network of sensors, developing improved algorithms for the expanded network, and installing new information/alert displays. The new information/alert displays will enable controllers to provide pilots with head wind gain or loss estimates for specific runways. These improvements will increase the system's windshear detection capability and reduce false alarms. Improvements are also expected to reduce maintenance costs. Initially, 83 airports have been identified to receive LLWAS-3; LLWAS-3 is scheduled to be fully deployed by CY 2001.

In the future, LLWAS-3 and TDWR will work in conjunction with one another and provide a synchronous alarm of windshear to the air traffic controller; in fact, development of a system is underway that will integrate the information from these two systems into a single windshear display. Investigation is also underway on how integrated windshear information can best be communicated or displayed to the pilot. Also, studies will be conducted to evaluate other sensors for the airport approach and departure corridors. These sensors are intended to provide windshear detection out to three miles from the touchdown zone.

The Surface Weather Observing Program. The FAA has taken responsibility for observations at many airports all across the country. To provide the appropriate observational service, FAA will use automated systems, human observers, or a mix of the two. It has been necessary to place airports into four categories according to the number of operations per year, any special designation for the airport, and the frequency at which the airport is impacted by weather.

- Level D service is provided by a stand-alone Automated Weather Observing System (AWOS) or an Automated Surface Observing System (ASOS). In the future, Level D service may be at as many as 400 airports.

- Level C service includes the ASOS/AWOS plus augmentation by tower personnel. Tower personnel will add to the report observations of thunderstorms, tornadoes, hail, tower visibility, volcanic ash, and virga when the tower is in operation. Level C service includes about 250 airports.
- Level B service includes all of the weather parameters in Level C service plus Runway Visual Range (RVR) and the following when observed--freezing drizzle versus freezing rain, ice pellets, snow depth and snow increasing rapidly remarks, thunderstorm/lightning location remarks, and remarks for observed significant weather not at the station. Level B service includes about 57 airports.
- Level A service includes all of the weather parameters in Level B service plus 10-minute averaged RVR for long-line transmission or additional visibility increments of 1/8, 1/16, and 0 miles. Level A service includes about 78 airports.

Automated surface weather observing systems will provide aviation-critical weather data (e.g., wind velocity, temperature, dew point, altimeter setting, cloud height, visibility, and precipitation type, occurrence, and accumulation) through the use of automated sensors. These systems will process data and allow dissemination of output information to a variety of users, including pilots via computer- generated voice.

FAA has deployed Automated Weather Observing Systems (AWOS) at over 200 airports to provide the basic aviation weather products directly to pilots approaching the airport. The majority of these systems were installed at various non-towered airports to enhance aviation safety and the efficiency of flight operations by providing real-time weather data at airports that previously did not have local weather reporting capability. These systems are built to the standards of quality necessary to ensure the safety of flight operations and are available off-the-shelf as a commercial product.

The FAA has negotiated with the National Oceanic and Atmospheric Administration (NOAA) to procure, install, operate, and maintain Automated Surface Observing Systems (ASOS) at the remaining airports where the FAA provides observations and at additional non-towered airports without weather reporting capabilities. A production contract was awarded in February 1991. The FAA will be sponsoring, as part of the reimbursable agreement with NOAA, 537 systems with an option for 228 additional systems. The current buy of FAA-sponsored systems is for 304 of which 292 were installed by August 1997.

The AWOS/ASOS Data Acquisition System (ADAS) will function primarily as a message concentrator and will collect weather messages from AWOS and ASOS equipment located at controlled and non-controlled airports within each air route traffic control center's (ARTCC) area of responsibility. ADAS will distribute minute-by-minute AWOS/ASOS data to the Weather and Radar Processor (WARP) and the Data Link Processor (DLP) within the center in which it is installed. ADAS will also distribute AWOS data to the National Airspace Data Interchange Network (NADIN) which will in turn forward the data to Weather Message Switching Center Replacement (WMSCR) for further distribution. The DLP (via Mode S) will make weather data available, on a timely basis, to pilots and air traffic controllers within the "local" area as well as other users. Field implementation of ADAS has started and will be completed in 1998.

AWOS for Non-Federal Applications. Under the Airport Improvement Program (AIP), state and other local jurisdictions may justify to the FAA their need to enhance their airport facilities. Upon approval, these improvements may be partially funded by the FAA using resources from the Airway Trust Fund. The local airport authority becomes responsible for the remainder of the funding necessary to complete the procurement as well as the funding for the regular maintenance. The addition of an AWOS is one of the improvements that qualify for AIP funding assistance. Systems that qualify must meet certain standards which are defined in an FAA Advisory Circular on Non-Federal Automated Weather Observing Systems.

There are currently five versions of the non-Federal AWOS. An AWOS-A provides only altimeter setting. The AWOS I system contains sensors to measure wind direction and speed, ambient and dew point temperatures, altimeter setting, and density altitude. The AWOS II contains the AWOS I sensors plus a visibility sensor; AWOS III adds a cloud height sensor to an AWOS II. AWOS IV will include AWOS III capabilities plus the option for precipitation identification, thunderstorm detection, and runway surface condition. Most importantly, all versions are required to have the capability to broadcast a minute-by-minute update of the current weather to the pilot by radio, using a computer-generated voice output. AWOS III also enables the pilot, as part of their preflight activities, to call the

AWOS and obtain the current weather observation. In addition, the observation may be transmitted to the database within the national weather network.

There are more than 275 non-Federal AWOS locations. Some of these are capable of reporting through a geostationary communications satellite, and many more will acquire that capability during the year. These observations will be entered into the national network for use in support of the NAS and the national weather network.

The New Generation Runway Visual Range (RVR) program provides for a new generation RVR sub-element of the NAS. The RVR provides runway visual range information to controllers and users in support of precision landing and takeoff operations. The new generation RVR incorporates state-of-the-art sensor technology and imbedded remote maintenance monitoring. FAA plans to procure and install these RVR systems at all new qualifying locations. FAA plans also call for the replacement of many existing RVRs in the NAS inventory.

The RVR provides for near real-time measurement of visibility conditions along a runway (up to three points along the runway can be measured-- touchdown, midpoint, and rollout) and reports these visibility conditions to air traffic controllers and other users. The system automatically collects and formats data from three sensors: a visibility sensor--forward scatter meters will replace the transmissometers currently in use, a runway light intensity monitor for both runway edges and center-line lights, and an ambient light sensor which controls computer calculations using a day or night algorithm. The data processing unit calculates RVR products and distributes the products to controllers and other users.

A total of 528 RVR visibility sensors will be deployed at 264 airport locations. Delivery of the new RVR sensors began in November. Enhancements are planned to interface with the Tower Control Computer Complex and the ASOS by 1998.

Airport Surveillance Radar-9 Weather Modular Enhancement. The Weather Modular Enhancement will be an add-on modification to the existing Airport Surveillance Radar-9 (ASR-9) and will provide air traffic controllers with information on low level windshear associated with microbursts and gust fronts in the vicinity of the airport. Presently, the ASR-9 weather data that are available consist of the six intensity levels as defined by the NWS.

En Route Aviation Weather Programs

The FAA is procuring the Operational and Supportability Implementation System (OASIS) to improve weather products, flight information, aeronautical data collection, analysis, and timeliness of dissemination and, thereby, enhance the safety and efficiency of the NAS. OASIS will replace the Model 1 Full Capacity Flight Service Automation System, which includes the Aviation Weather Processor. OASIS will also integrate the Interim Graphic Weather Display System functions. It will also include several automated flight service data handling capabilities. This configuration will be its initial deployment capability.

Future enhancements leading to the full capability deployment will include: interactive alphanumeric and graphic weather briefings, direct user access terminal (DUAT) service functionality, automated special use airspace, and training support. OASIS will support flight planning, weather briefings, NOTAM service, search and rescue, and pilot access terminal services.

Each OASIS will have interfaces with its host Air Route Traffic Control Center (ARTCC) computer, U.S. Customs Service, Treasury Department, foreign ATC facilities, and WMSCR. WMSCR will relay most of the weather information, data, and pilot reports (PIREP).

The Next Generation Weather Radar (NEXRAD), known operationally as the Weather Surveillance Radar -1988 Doppler (WSR-88D), is a multiagency program that defined, developed, and implemented the new weather radar. Using the principles of the Doppler effect and state-of-the-art software, the WSR-88D is able to detect many properties of the atmosphere that were not heretofore routinely sampled. Departments of Commerce (DOC), Defense (DOD), and Transportation (DOT) jointly fund WSR-88D implementation costs; DOC is responsible for program management. The WSR-88D was developed and acquired under the auspices of the NEXRAD Program Council within the Office of the Federal Coordinator for Meteorology.

Field implementation began in 1990 and was completed in 1996. There are a total of 161 WSR-88D systems deployed within the three agencies. The FAA sponsored 12 systems in Alaska, Hawaii, and the Caribbean. DOC and DOD WSR-88Ds provide coverage over the continental United States.

The FAA emphasized the development of WSR-88D algorithms that take advantage of the improved detection of precipitation, wind velocity, and hazardous storms. The FAA also stressed that these algorithms provide new or improved aviation-oriented products. These improvements in detection of hazardous weather will reduce flight delays and improve flight planning services through aviation weather products related to wind, windshear, thunderstorm detection, storm movement prediction, precipitation, hail, frontal activity, and mesocyclones and tornadoes.

WSR-88D data provided to ATC through the WARP will increase aviation safety and fuel efficiency. In addition to the benefits to be gained in today's system, future automated ATC functions and improved traffic-flow management require reliable and accurate weather data to maximize fuel savings and manpower productivity.

In addition, the three funding agencies support the field sites through the WSR-88D Operational Support Facility (OSF) at Norman, Oklahoma. The OSF provides software maintenance, operational troubleshooting, configuration control, and training. Planned product improvements include a shift to an open architecture and the development of more algorithms associated with specific weather events, such as hurricanes. Field sites continually provide the OSF with suggestions for improvement of existing algorithms and applications of products.

A new Air Route Surveillance Radar (ARSR-4) provides the ARTCCs with accurate multiple weather levels out to 200 nautical miles. The ARSR-4 is the first en route radar with the ability to accurately report targets in weather. The ARSR-4 is used to provide weather information to supplement the WSR-88D in areas such as the Rocky Mountains. The ARSR-4 is a joint FAA/USAF funded project. Forty joint radar sites were installed during the 1992-1995 period.

The Weather Systems Processor (WSP) program will provide an additional radar channel for processing weather returns and de-alias returns from the other weather channel in the ASR-9. The displays of convective weather, microbursts, and other wind shear events will provide information for controllers and pilots to help aircraft avoid those hazards. A prototype has been demonstrated and limited production will commence in the fourth quarter of CY 1997. Full productions deliveries are expected to be completed by 2001.

Aviation Weather Processing Programs

The FAA participates in coordination among federal agencies, concerning Automated Weather Information Systems (AWIS). The OFCM-sponsored Committee for AWIS developed a national plan which integrates requirements, development, and implementation activities associated with AWIS programs and projects of the DOC, DOD, and DOT. Under this plan, the three departments are cooperating in the review, clarification, and allocation of requirements to the various specialized elements of the planned national AWIS. The intent of this activity is to avoid unnecessary duplication of development efforts and to ensure the sharing of information and products in the operational phase. New interface requirements are being defined and plans for product sharing are being developed. Within FAA, new interfaces with elements of the NAS will be developed to support the aviation weather information dissemination function. One interface will enable the DLP to provide WSR-88D mosaics for communication to pilots as well as receive PIREPs from aircraft in-flight.

The Meteorologist's Weather Processor (MWP) is a commercially available, interactive workstation which was procured through a series of 5-year leases. It is used primarily by NWS meteorologists who are assigned to Center Weather Service Units (CWSU) at each of the ARTCCs. The MWP receives a stream of products and data fields which is controlled by the vendor but originates with the NWS. This system improves the dissemination of aviation weather information throughout the NAS, including pilots, air traffic controllers, flight service specialists, traffic management specialists, and NWS CWSU meteorologists. The MWP provides specialized automated tools to these meteorologists to enhance their ability to summarize hazardous weather information and ensure that the latest and best information is disseminated to all users.

The original deployment of MWP was completed in 1992. The MWP, leased in the second 5-year period, will interface with the WARP, which should become operational in the late 1990s. The MWP also interfaces with NWS offices to permit a rapid flow of weather information to and from each FAA center. Future leases of the MWP will consider the possibility of utilizing services available from the NWS' Advanced Weather Interactive Processing System (AWIPS).

The Weather and Radar Processor (WARP) will automatically create unique regional, WSR-88D-based, mosaic products. WARP will send these products, along with other time-critical weather information, to controllers through the Advanced Automation System (AAS) and to pilots via the aeronautical data link. WARP will greatly enhance the dissemination of aviation weather information throughout the NAS. It will have interfaces with WMSCR through NADIN, ADAS, OASIS, and DLP.

The Direct User Access Terminal (DUAT) system has been operational since February 1990. Through DUAT, pilots are able to access weather and NOTAMs and also file their IFR and/or VFR flight plans from their home or office personal computer. This system will eventually be absorbed into OASIS.

Aviation Weather Communications

It should be noted that FAA communications systems are multipurpose. Weather data, products, and information constitute a large percentage of the traffic, as do NOTAMS, flight plans and other aeronautical data.

The National Airspace Data Interchange Network (NADIN II) packet-switched network was implemented to serve as the primary interfacility data communications resource for a large community of NAS computer subsystems. The network design incorporates state-of-the-art packet-switching technology into a highly connected backbone network, which provides extremely high data flow capacity and efficiency to the network users. NADIN II consists of operational switching nodes at each Area Control Facility and two network control centers (and nodes) at the National Aviation Weather Processing Facilities at Salt Lake City, Utah, and Atlanta, Georgia. It will interface directly to WMSCR, WARP, MWP, ADLP, ADAS, TMS, ACCC, and the Consolidated NOTAM System. NADIN II also may be used as the intra-facility communications system between these (collocated) users during transition to end state.

The Weather Message Switching Center Replacement (WMSCR) replaces the weather message switching center (WMSC) located at FAA's National Communications Center (NATCOM), Kansas City, Missouri, with state-of-the-art technology. It will perform all current alphanumeric weather data handling functions of the WMSC and the storage and distribution of NOTAMs. WMSCR will rely on NADIN for a majority of its communications support. The system will accommodate graphic data and function as the primary FAA gateway to the NWS' National Centers for Environmental Prediction (NCEP)--the principal source of NWS products for the NAS.

To provide for geographic redundancy, the system will have nodes in the NADIN buildings in Atlanta, Georgia, and Salt Lake City, Utah. Each node will support approximately one-half of the United States and will continuously exchange information with the other to ensure that both nodes have identical national databases. In the event of a nodal failure, the surviving one will assume responsibility for dissemination to the entire network.

The Aeronautical Data Link Program (ADLP) will implement the Data Link Processor (DLP) to support weather services for aircraft utilizing the discreetly addressed data link capability of the FAA's Mode Surveillance (MODE S) system. It will receive downlink requests for weather products from aircraft, formulate replies, and return them to the pilot via the data link. This will improve air-ground communication services by expanding the pilot's ability to access desired weather information while operating on the airport surface or in flight. It will also reduce the workload of flight service specialists and air traffic controllers who currently provide the only means of access to these data.

Initially, the data-link services to be implemented will be for automated databases which currently exist or are planned to be operational in the near term. These include alphanumeric products, such as SIGMETs, AIRMETs, surface observations, terminal forecasts, winds aloft, pilot reports, and alphanumeric radar summary information. Installation of this system began in 1991 and is continuing as programmed. The ADLP will be enhanced to support additional weather information (including windshear advisories) and ATC tower applications (including digital ATIS) and to provide expanded data-link communications functions in support of ATC data-link services.

The Worldwide Aeronautical Forecast System (WAFS) is a three geosynchronous satellite-based system for collecting and disseminating aviation weather information and products to/from domestic or international aviation offices as well as in-flight aircraft. The information and products are prepared at designated offices in Washington, D.C., and Bracknell, United Kingdom. The U.S. part of WAFS is a joint project of the FAA and NWS to meet requirements of the member states of the International Civil Aviation Organization (ICAO). FAA funds the satellite communications link, and the NWS provides the information stream.

Two of the three satellites are funded by the United States. The first is located over the western Atlantic with a footprint covering western Africa and Europe, the Atlantic Ocean, South America, and North America (except for the West Coast and Alaska). The second U.S.-funded satellite is positioned over the Pacific and covers the U.S. West Coast and Alaska, the Pacific

Ocean, and the Pacific rim of Asia. The third satellite is stationed over the western Indian Ocean and covers the remaining areas of Europe, Asia, and Africa.

The data available via WAFS include flight winds, observations, forecasts, SIGMETs, AIRMETs, and hazards to aviation including volcanic ash clouds.

Aviation Weather Research Program

Working closely with the Integrated Product Team for Surveillance and Weather, the Aviation Weather Division sponsors research on specific aviation weather concerns, such as in-flight icing. This research is performed through collaborative efforts with the National Science Foundation (NSF), the NWS, and the Massachusetts Institute of Technology's Lincoln Laboratory. A primary concern is the effective management of limited research, engineering, and development resources.

The Aviation Gridded Forecast System (AGFS) will capitalize on significant advances in atmospheric sciences and computer technology to develop a four- dimensional database of weather phenomena that is of major importance to aviation. Data inputs from ASOS, radar wind profilers, satellite sensors, ACARS, radiosondes, and ITWS will provide the most accurate current and forecast variables with high spatial and temporal resolution. High technology computers will allow the forecasts to be run more often in a rapid update cycle. AGFS is being designed to generate timely regional and national aviation weather products for immediate use by non-meteorological personnel, such as pilots, air traffic controllers, traffic management personnel, and flight service specialists. The products will be available on the aeronautical data link. AGFS implementation is expected in the late 1990's.

Improved Aircraft Icing Forecasts. The purpose of this initiative is to establish a comprehensive multiyear research and development effort to improve aircraft icing forecasts as recommended in the *National Plan to Improve Aircraft Icing Forecasts*. This plan was jointly developed under the aegis of OFCM by the DOC, DOD, DOT, NSF, and the National Aeronautics and Space Administration to provide the NWS with an improved aircraft icing forecast capability. The objectives of this plan are to develop (1) an icing severity index, (2) icing guidance models, and (3) a better comprehension of synoptic and mesoscale conditions leading to icing. The result of this effort will be an improved icing forecasting capability that provides pilots with more timely and accurate forecasts of actual and expected icing areas by location, altitude, duration, and potential severity.

Convective Weather Forecasting. The purpose of this research effort is to establish more comprehensive knowledge on the conditions that trigger convection and thunderstorms and, in general, the dynamics of a thunderstorm's life cycle. The program will lead to enhanced capability to predict growth, movement, and type of precipitation from thunderstorms. Gaining this forecast capability will allow better use of the airspace and help aircraft avoid areas with hazardous convective conditions.

Model Development and Enhancement. This research is aimed at developing or improving models to better characterize the in-flight environment and, thereby, deliver superior aviation weather products to end users.

Weather Support to Deicing Decision Making. There is a need to develop products that provide forecasts on the intensity of snow and freezing rain, and how or when these phenomena will change in the short term. This information is needed by airport management to determine when an aircraft will require deicing before take-off. The water content of snow is believed to be an important factor.

Other Aviation Weather Research. Other aviation weather research programs that are continuing, but at a lower level of funding, pertain to ceiling and visibility, turbulence detection, and convective weather detection.

UNITED STATES COAST GUARD

Among the United States Coast Guard's (USCG) activities are: marine and coastal weather observations by ocean-going cutters and at shore stations; collection and transmission of marine weather observations received from ships at sea by Coast Guard communications stations; broadcast of NWS marine weather forecasts, weather warnings, and weather facsimile charts to marine users; monitoring the seasonal iceberg threat to the North Atlantic shipping lanes off the Grand Banks of Newfoundland and the transmission of warning messages defining the iceberg limits; providing facilities and ship support to maintain the National Data Buoy Center (NDBC) network of automated environmental monitoring platforms; and operation of long-range radionavigation systems (OMEGA and LORAN-C), which are used by the meteorological sounding instruments essential to observational networks.

USCG ocean-going cutters and coastal stations provide weather observations to the NWS. Coast Guard communications stations broadcast NWS marine forecasts, weather warnings, and weather facsimile charts and, also, collect weather observations from commercial shipping for the NWS. In addition, Coast Guard groups broadcast NWS marine forecasts and weather warnings to users.

USCG conducts the International Ice Patrol (IIP) which uses radar-equipped aircraft to patrol the area of the Grand Banks off of Newfoundland during the iceberg season. IIP determines the geographic limits of the iceberg hazard and, twice daily, broadcasts iceberg warning bulletins and daily ice facsimile charts which depict the limits of all known ice. These broadcasts are made to the marine community during the period of iceberg danger. IIP operates an Iceberg Drift and Deterioration Model to predict iceberg distribution between IIP reconnaissance flights. IIP annually archives iceberg data reflecting all targets (both known icebergs and unidentified radar targets). The data is forwarded to the National Snow and Ice Data Center. The listing contains iceberg sighting data along with the last model-predicted position.

Various USCG facilities support NOAA's National Data Buoy Center (NDBC). NDBC's automated network of environmental monitoring platforms in the deep ocean and coastal regions provide accurate and reliable data for NWS and other users. Fifteen Coast Guard personnel fill key technical and operating positions within NDBC; the senior Coast Guard officer assigned serves as the NDBC Deputy Director. Coast Guard cutters provide the deployment and retrieval of data buoys and service visits to both buoys and coastal stations, expending up to 280 cutter days annually. Coast Guard aircraft, boat, and shore facilities also provide NDBC support.

USCG operates navigation stations providing OMEGA and LORAN-C radionavigation signals for the aviation and navigation communities. These signals also support the operation of meteorological sounding instruments essential to observation networks. OMEGA will cease operations September 30, 1997.

Coast Guard Marine Science Technicians receive basic training in meteorology as a major part of the training for their specialty.

Meteorological activities are coordinated by the Ice Operations Division of the Office of Navigation Safety and Waterways Services at Coast Guard Headquarters. The Coast Guard NDBC operation is managed at Coast Guard Headquarters by the Short Range Aids to Navigation Division of the Office of Navigation Safety and Waterways Services. Field management of the meteorological activities is a collateral function of the Coast Guard district and area staffs.

No Coast Guard unit is dedicated solely to meteorology; all facilities perform a variety of missions. No capital investments in meteorological facilities are planned or contemplated.